Surface Textures to Control Phase Behavior

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The success of rough substrates designed for superhydrophobicity relies crucially on the presence of air pockets in the roughness grooves. This air is supplied by the surrounding environment. However, if the rough substrates are used in enclosed configurations, such as in fluidic networks, the air pockets may not be sustained in the roughness grooves. In this work a design approach based on sustaining a vapor phase of the liquid in the roughness grooves, instead of relying on the presence of air, is proposed. The resulting surfaces, referred to as vapor stabilizing substrates, are deemed to be robust against wetting transition even if no air is present. Applications of this approach include low drag surfaces, nucleate boiling, and dropwise condensation heat transfer, among others. The concept can potentially be generalized to other transitions on the phase diagram, thus enabling the design of textured surfaces to control phase behavior in general.